HALO™ Network

The Birth of Stratospheric Communications Services

& The Decline of Satellite Networks

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ABSTRACT

Stratospheric communications is a grand opportunity, one that, when fully realized, will radically alter how countries will best serve the communications needs of their people. By being able to match communications data density to the demographics of end users within a metropolitan area, and by having round trip delays allowing real-time, interactive, content-rich (multimedia) communications, a stratospheric platform will be able to deliver wireless broadband services vital to expanding commerce and to sustaining economic growth. Both network parameters, i.e., data density and round-trip delay, can be orders of magnitude better suited to serving multiple thousands of end users in major cities than feasible with even the next-generation, big LEO satellite constellations. Through the hard work of talented and dedicated individuals, stratospheric networks will rapidly evolve. In less than ten years, stratospheric platforms can displace satellites as the means of deploying broadband services, especially those services requiring interactivity and rich content. Prophetically speaking, the birth of a stratospheric communications layer may herald the decline of satellite networks. Indeed, the participants of this <u>First Stratospheric Platforms</u>

Systems Workshop are embarking upon a bold journey in the history of global communications.

Angel Technologies Corporation and its development partners are pioneering broadband wireless millimeter wavelength services from piloted High Altitude Long Operation (HALO) aircraft. Scaled Composites (www.scaled.com) in Mojave, California, a subsidiary of Wyman Gordon (www.wyman-gordon.com), is flight testing the HALO/Proteus "proof of concept" full-scale airplane. Scaled's sister company, Scaled Technology Works (www.scaled-works.com), in Montrose, Colorado, will Type Certify the airplane through the FAA and will be the series producer of the airplane. Angel and Raytheon have demonstrated a symmetric wide-band link from a rooftop, tracking antenna to a general aviation airplane in flight, through which T1 access, ISDN access, web browsing, high-resolution videoconferencing, large file transfers, and Ethernet LAN bridging were delivered.

The HALO/Proteus airplane will be the central node of a broadband communications network, the HALO Network, having a star topology. The network will utilize packet switching to offer bit rates to each of thousands of end user in the multi-megabit per second range. A variety of spectrum bands licensed for commercial wireless services could provide the needed MMW-carrier bandwidth. The signal footprint of the network, the Cone of Commerce, will cover a typical large city and its surrounding communities. HALO aircraft will fly above commercial airline traffic. A fleet of aircraft will be operated in shifts to achieve around-the-clock service.

The HALO Network has only one uniquely tailored communications hub per city in a simple "star" configuration. Whereas, the big LEO satellite constellations will require a "mesh" network of many "nodes" with each node having multiple inter-satellite links. Consequently, the HALO Network will be much simpler to deploy, diagnose, maintain, and upgrade. The airborne hub can be routinely serviced for optimal performance. Whereas, the components used in a satellite constellation will steadily degrade following orbital insertion. Highly competitive terrestrial broadband wireless technology will be used, rather than space-rated technologies optimized for a unique satellite buss. Spectrum opportunities for the HALO Network can be pursued on a city-by-city basis instead of negotiated on a global scale. Finally, the HALO Network will be an evolving "network solution" that can be deployed one market at a time to ease the financing commitment of growing a global business.

Keywords: HALO Aircraft, HALO Network, Cone of Commerce, broadband wireless services, metropolitan area network, switched broadband, megabit data services, packet switching, wireless multimedia, satellite concentrator.

1. The Decline of Satellites

Today's global satellite industry had its genesis in the primordial broth of post-WWII adversity when the orbiting Sputnik sparked an urgent national response by the United States. While Cold War tensions remained dangerously high for more than three decades thereafter, the Soviet Union and the United States both appropriated public funds, numbering more than hundreds of billions of dollars, to sustain the ominous policy of mutually assured destruction. Satellite technologies and capabilities were rapidly evolved, through public subsidization, for national security objectives, intelligence operations, and the detection and tracking of intercontinental ballistic missile launches. Aerospace corporations grew to huge sizes. Government policy decisions, as they affected public funding of technology and the assignment of public assets, especially communications spectrum, were strongly directed by lobbyists loyal to the aerospace behemoths. At the end of the Cold War, these corporations, with their large staffs and strong political influences, suddenly had a very uncertain future. Commercial wireless communications were quickly recognized as significant business opportunities, perhaps seized upon as a "survival strategy," by those companies grappling with Defense Conversion. Though satellite networks are being developed to be deployed to offer a wide variety of communications services, are satellites the appropriate means for realizing a truly Global Telecosm of the 21 st Century?

GEO satellites are well suited for delivering common broadcast signals, like television, to end users within a continent. Advanced broadcast satellites are expected to have multiple beams, each delivering unique "local content" over a large trading area. GEO satellites can be very effective at transferring large data files and aggregated data traffic across countries and between continents, if high latency is acceptable to the customer and high data rates are desired on a dedicated basis.

On the other hand, GEO satellites, when compared to terrestrial networks, are not as well suited to the tasks of connecting regional telecommuters to their corporate backbone and of transacting small information packets. GEO satellites are less desirable than terrestrial networks for performing highly interactive collaborative work, now commonly occurring on modern corporate and campus networks, that may involve telecommuters located at a metropolitan scale of distance from their server. Though GEOs offer a large amount of bandwidth downstream, they are challenged to offer a high enough upstream rate for truly interactive broadband services involving peer-to-peer active collaboration. The cost to provide sufficient power in terrestrial end-user terminals in order to uplink the signals to the satellite at a high rate, especially through dense rain, are considered too high for the consumer, the small office/home office (SOHO), and even for most small- and medium-size businesses.

The proposed big LEO networks may someday globally interconnect

solitary individuals who are far removed dense population centers. This is the business model of Iridium LLC. Since a LEO satellite orbits the Earth nearly once every 1.5 hours, it can be accessed from an end user's antenna on the ground for only several or more minutes. Consequently, to offer uninterrupted data services, many satellites must be deployed in multiple rings, and special protocols are needed to softly "hand off" all of the end users from one satellite leaving the region to the next satellite entering that region. At any instant of time, many communications nodes of the LEO constellation will be over oceans, mountains, and deserts, not over cities. The size of the constellation must be large, numbering multiple tens to hundreds of satellites, and the network complexity will be unprecedented. The demand for capital will be large, as demonstrated by Iridium LLC, and the financial commitment must be "all or nothing." The financial struggles of Iridium LLC beckons scrutiny, for the lessons to be learned may be relevant to other proposed big LEO constellations. The ITU has granted vital spectrum bandwidth to satellite networks for their exclusive use. In each such grant by the ITU, the corresponding spectrum is no longer available for use by stratospheric communications networks.

LEO constellations involve high technical risk. Some of the risks anticipated prior to launch will be fully understood only after the entire constellation has been deployed and when the operator attempts to make the network fully operational. Problems, not imagined, may be discovered only after deployment; too late to introduce effective fixes. Depending upon the severity of a common design flaw, the performance of the network may prevent realization of the desired profit margin. This is a concern to all proposed LEO communications networks, since state-of-the-industry, commercial-grade electronics must be used, not "radiation hard" components, for example, to achieve desired capabilities. Intrinsic risks of LEO constellations have a biological analogy: reduction of a given species' gene pool makes that entire species vulnerable to a single threat. By replicating the same basic engineering template in order to contain manufacturing costs, the entire LEO constellation becomes endangered by common design/engineering flaws. The evolution of the technology employed in a constellation is halted typically two or more years before the network is deployed; and it will remain "frozen" for each year of the constellation's operating lifetime. The performance of the constellation will degrade steadily through the damaging effects of ionizing radiation of solar and cosmic origins, and from thermal stresses occurring when the satellite moves from the Earth shadow to direct sunlight and back to the Earth shadow every orbital period.

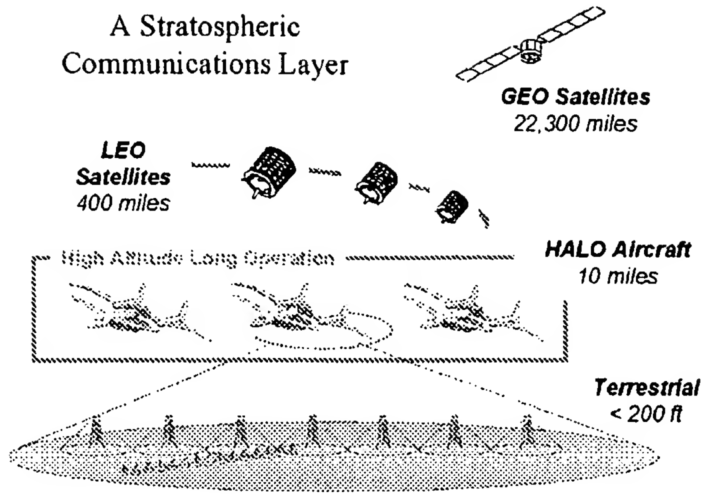
In striking contrast, stratospheric networks can be steadily evolved for each successive city. They can accept technologies germane to terrestrial wireless communications networks and state-of-the-industry data communications networks that are being rapidly evolved in response to global competition. Each stratospheric

node can be routinely serviced and upgraded to best meet the communications needs of the local population. Unlike a large LEO constellation, the evolutionary modalities available to stratospheric networks ensure a rich taxonomy expressing competition and species differentiation. Since each stratospheric platform will reside only above a region having a dense concentration of end users, its requisite financial commitment will not be squandered over oceans, mountains, and deserts. Financing can be organic instead of "all or nothing." And the efficiency of capital can be comparatively high when measured in terms of network capacity delivered to the addressable market per dollar invested. In summary, the stratospheric layer will promote technological innovation, to be evidenced by this workshop, and a rapid evolution of communications networks will likely ensue, one that can propel electronic commerce into the 21st Century.

2. Birth Of The HALO Network

I am pleased to report on the progress of Angel Technologies (www.broadband.com). HALO aircraft represent a *new layer* in the hierarchy of wireless communications, a 10-mile tall tower in the stratosphere above rain showers and below meteor showers; i.e., a communications layer that will be high above terrestrial towers and well below satellite constellations. For broadband wireless services, the airborne node of the HALO Network can extend wireless broadband services to nearly every potential end user residing in a super-metropolitan area, i.e., several thousands of square miles, and can do so with an inexpensive infrastructure measured in the cost per dwelling passed.

My talk will present the architecture and explain the concept of operations of the HALO Network. It will describe key characteristics of the HALO aircraft, the network equipment onboard, and the user terminals. Earlier papers [1,2] introduced the HALO Network. The paper by Djuknic[3] highlighted the unique advantages of stratospheric platforms for providing wireless communications services and is a good reference for use by the engineering community.

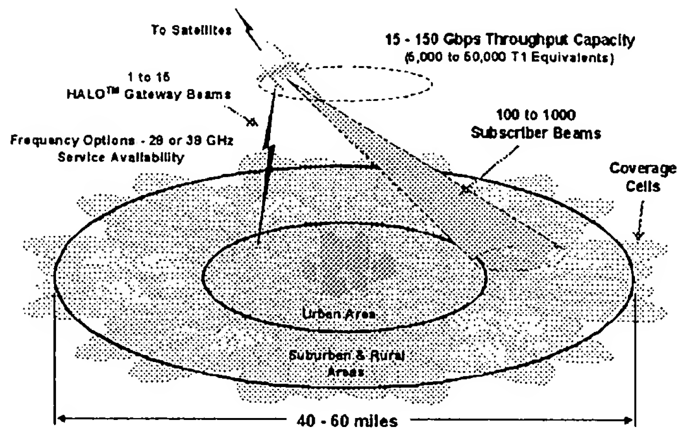


Angel Technologies Corporation and its partners are highly encouraged by technological and manufacturing advances in the aviation, millimeter wave wireless, data communications, computer networking, and multi-media communications fields. We believe that we have an opportunity to deploy a novel broadband communications network. Our work suggests the HALO Network will be able to offer wireless broadband communications services to a "super metropolitan area," an area encompassing a typical large city and its surrounding communities. The aircraft will carry the "hub" of the network from which we will serve multiple tens, perhaps multiple hundreds, of thousands of end users on the ground. Each end user will be able to communicate at multi-megabit per second bit rates through a simple-to-install user terminal. The HALO Network will be evolved at a pace with the emergence globally of key technologies from the data communications, millimeter wave RF, and network equipment fields. The HALO Network will be a template that Angel will evolve and replicate to grow a global business.

Much of the technology needed already exists. The engineering development effort is thus focusing on adapting and integrating components and subsystems from competitive markets. Proven technology, components, and subsystems will be used as pervasively as possible. Adaptation has been given priority over innovation and basic development.

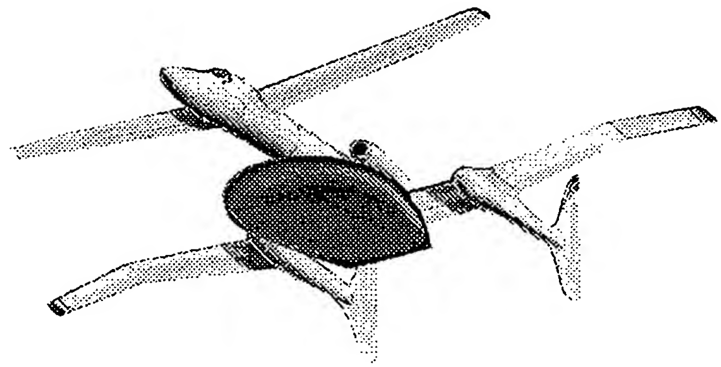
The HALO aircraft will be operated in shifts from regional airports. While on the ground, the network equipment aboard the aircraft will be assessed, maintained and upgraded on a routine basis to ensure optimal performance. Our operating plan specifies regular equipment upgrades in order to leverage technology advances for yielding lower cost and weight and for providing increased performance.

A Wireless Broadband Metropolitan Area Network
Provided by HALO™ Aircraft



The HALO/Proteus airplane has been specially designed to carry the hub of the HALO Network. The airplane can carry a weight of approximately one ton in the stratosphere. The airplane is essentially an equipment bus from which commercial wireless services will be offered. A fleet of aircraft will be cycled in shifts to achieve continuous service. Each shift on station will have an average duration of approximately eight hours.

The HALO/Proteus airplane will maintain station at an altitude above 51 Kft in a volume of airspace resembling a distorted torus with a typical diameter less than 8 nautical miles. The look angle, defined to be the angle subtended between the local horizon and the airplane with the user terminal at the vertex, will be greater than a minimum value of 20 degrees. [The minimum look angle (MLA) for a given user terminal along the perimeter of the service footprint is defined to occur whenever the airplane achieves the longest slant range from that terminal while flying within the designated airspace.] Under these assumptions, the signal footprint will cover an area of approximately 2,000 to 3,000 square miles, an area large enough to encompass a typical city and its neighboring communities. Such a high value for the MLA ensures a line-of-sight connection to nearly every rooftop in the signal footprint, and high availability during heavy rainfall for most of the major cities in North America, for example, especially for broadband data rates propagated in the K/Ka bands. Consequently, the HALO aircraft can provide a signal footprint that is effectively ubiquitous, and potential end users too expensive to reach through terrestrial infrastructure can then gain access through the 10-mile tower offered by the airborne HALO communications node.



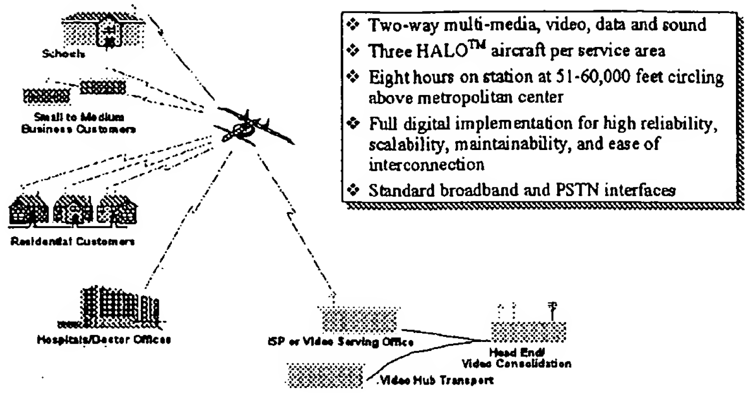
By selecting MMW frequencies, a broadband network of high capacity can be realized. Carrier frequency bandwidths on the scale from 100 MHz to 1,000 MHz have been licensed and may be made available through partnerships, or through allocation by government spectrum regulatory authorities. Small antenna apertures on the scale of 1 foot will provide narrow beamwidths, and thus the user terminals can be compact yet offer high gain. Also, a multi-aperture antenna array can fit in an airborne pod with dimensions practical and acceptable to aerodynamics.

The airborne antenna array can be configured to project a pattern of many cells numbering from one hundred to more than one thousand. Each cell on the ground will cover an area of a few square miles to several tens of square miles. A variety of spectrum re-use plans can be selected to cover the signal footprint with patterns of cells. For example, each cell can use one of four frequency sub-bands, and a fifth sub-band can be used for gateways (connections to the public network or to provide wideband links to dedicated users). By reusing the spectral bandwidth, a total network capacity in the range of 10 Gbps to 100 Gbps appears feasible.

3. The HALO Network Concept

1. Overview

Many types of organizations—schools, hospitals, doctors' offices, and small to medium size businesses—around the world will benefit from the low pricing of broadband services provided by the HALO Network. Standard broadband protocols such as ATM and SONET will be adopted to interface the HALO Network as seamlessly as possible. The gateway to the HALO Network will provide access to the Public Switched Telephone Network (PSTN) and to the Internet backbone for such services as the World Wide Web and electronic commerce. The gateway will provide to information content providers a network-wide access to a large population of end users.



2. Desirable Features Of The HALO Network

Some of the desirable features of the HALO Network are:

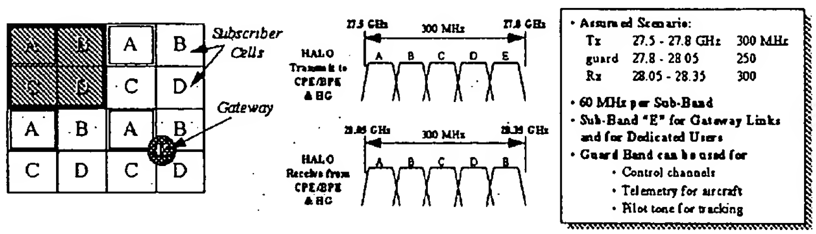
- Seamless ubiquitous multimedia services
- Adaptation to end user environments
- Rapid provisioning of end users
- Rapid deployment of complete network solutions to cities of opportunity
- Total coverage of a metropolitan center and its surrounding communities on the first day
- Access to the consumer, SOHO, and content information markets
- Easy upgrades of the entire network
- Steady improvement of performance through routine maintenance
- Integration of technologies from terrestrial communications networks, wireless and wired
- Enhances terrestrial broadband networks; serves end users in the 'shadows' of towers and relays
- Serves diffuse markets while allowing terrestrial networks to serve hot-spots
- Bandwidth on demand for efficient use of available spectrum.

1. Service Attributes

Various classes of service can be provided to end users sharing the bandwidth of a given beam, for example, 1 to 10 Mbps peak data rates to small businesses, and 10 to 25 Mbps peak data rates to business users with larger bandwidth appetites. Since each links can be serviced according to "bandwidth on demand," the bandwidth available in a beam can be shared between sessions concurrently active within that beam. While the average data rate may be low for a given user, the instantaneous rate can be grown to a specified upper bound according to demand. A dedicated beam service can also be provided to those end users requiring 25-155 Mbps.

2. Network Access

Various methods for providing access to the users on the ground are feasible. In one approach, each spot beam from the payload antenna serves a single "cell" on the ground in a frequency-division multiplex fashion with 5-to-1 frequency reuse, four for end user units and the fifth for gateways to the public network and to high-rate end users. Other reuse factors such as 7:1 and 9:1 are possible. Various network access approaches are being explored. The talk will summarize a few representative examples.



Cell Coverage by Frequency Division Multiplexing using Spot Beams

3. Network Services

The HALO node can provide a multitude of connectivity options. It can be used to connect physically separated Local Area Networks (LANs) within a corporate intranet through frame relay adaptation or directly through LAN bridges and routers; or it can provide videoconference links through standard T1 interface hardware. The HALO Network may use standard SONET and ATM protocols and equipment to minimize the cost of the equipment and to take advantage of the wide availability of such components.

1. **HALO Network Architecture**

At the apex of a wireless Cone of Commerce, the payload of the HALO aircraft serves as the hub of a star topology network for switching data packets between any two user terminals within the service footprint. A single hop with only two links is required, each link connecting the payload to an end user. The links are wireless, broadband and line of sight. Single link delays range from ~60 μsec under the airplane to ~200 μsec at the edge of the signal footprint. Information created outside the service footprint is delivered to an end user's terminal through terminals operated by businesses, Internet Service Providers (ISPs), or content providers within that region, and through the HALO Gateway (HG) directly connected to distant metropolitan areas via leased trunks. With a packet switch onboard the airplane, only two air links are required for terminal-to-terminal communications via the node in the stratosphere. The HG is a portal serving the entire network. It allows system-wide access to content providers or advertisers, and it allows

any end user to extend their communications beyond the HALO Network service area by connecting them to dedicated long-distance lines such as inter-metro optical fiber.

High rainfall rates can reduce the effective data throughput of the link serving a given end user. Angel plans to ensure the maximum data rate more than 99.7% of the time. The link margin will be sufficient to provide an acceptable minimum data rate more than 99.9% of the time, and to limit outages to small areas (due to the interception of the signal path by very dense rain columns) to less than 0.1% of the time. Angel plans to locate the HG close to the HALO orbit center to reduce the slant range from its high-gain antenna to the aircraft and correspondingly its signal path length through heavy rainfall. The link margin requirements have been assessed and are thought to be achievable due to having high power available for the airborne segment of the network communications equipment.

2. HALO Aircraft

The HALO aircraft is being flight-tested in Mojave, California. The first flight was accomplished there in July 1998 and the flight envelope is being steadily expanded. The aircraft has been specially designed for the HALO Network and it can carry a large pod suspended from the underbelly of its fuselage. The pod containing the antenna array interfaces to the fuselage via a pylon through which power and coolant flow. If encountering a persistent wind at altitude, the aircraft will vary its roll angle as it attempts to maintain its station. Various antenna concepts allow the signal footprint to be maintained on the ground as the airplane rolls.

3. Communications Pod

The HALO Network will use an array of narrow beam antennas on the HALO aircraft to form multiple cells on the ground. Each cell covers a small area, e.g., several to several tens of square miles. The wide bandwidths and narrow beamwidths of each beam or cell are achieved by using MMW carrier frequencies. Small aperture antennas with high gains can be used at opposite ends of the end user link, corresponding to the user terminal and the airborne antenna. A description of the network equipment was given in a prior technical paper.[1]

4. End User Terminals

The user terminal entails three major sub-groups of hardware: the RF Unit (RU) which contains the MMW Antenna and MMW Transceiver, the Network Interface Unit (NIU), and the application terminals such as PCs, telephones, video servers, video terminals, etc. The RU consists of a small dual-feed antenna and MMW transmitter and receiver mounted to the antenna. An antenna tracking unit uses a pilot tone transmitted from the HALO aircraft to point its

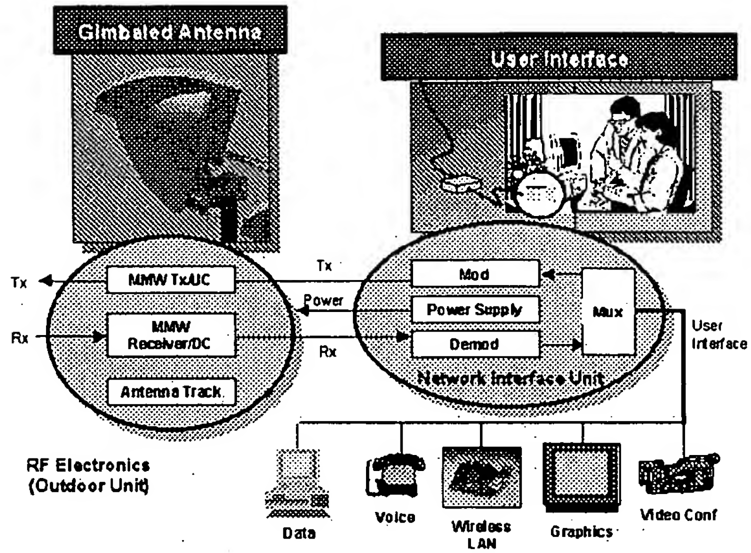
antenna at the airplane. The antenna tracks the airplane with a mount possessing low-rate two-axis gimbals. Other schemes for performing the auto tracking function are feasible and appear to be competitive in cost. The high-gain antenna is protected beneath a radome from wind loading and the weather.

The MMW transmitter accepts an L-band IF input signal from the NIU, translates it to MMW frequencies, amplifies the signal using a power amplifier to a transmit-power level of 100 - 500 mW and feeds the antenna. The MMW receiver couples the received signal from the antenna to a Low Noise Amplifier (LNA), down converts the signal to an L-band IF and provides subsequent amplification and processing before outputting the signal to the NIU. The MMW transceiver will process a single channel at any one time, perhaps as narrow as 40 MHz. The particular channel and frequency are determined by the NIU.

The NIU interfaces to the RU via a coax pair which transmit the L-band TX and RX signals between the NIU and the RU. The NIU comprises an L-band tuner and down converter, a high-speed demodulator, a high-speed modulator, multiplexers and demultiplexers, and data, telephony and video interface electronics. Each user terminal can provide access to data at rates up to 51.84 Mbps each way. In some applications, some of this bandwidth may be used to incorporate spread spectrum coding to improve performance against interference (if so, the user information rate would be reduced).

The NIU equipment can be identical to that already developed for LMDS and other broadband services. This reduces the cost of the HALO Network services to the consumer since there would be minimal cost to adapt the LMDS equipment to this application and we could take advantage of the high volume expected in the other services. Also, the HALO RU can be very close in functionality to the RU in the other services (like LMDS) since the primary difference is the need for a tracking function for the antenna. The electronics for the RF data signal would be identical if the same frequency band is utilized.

Premise Equipment



5. **HALO/Satellite Opportunities**

The HALO Network provides data densities nearly one thousand times higher than proposed satellites, while having round trip time delays appropriate for interactive broadband services. Whereas, the delays through satellite communications nodes, even through LEO satellite nodes, are too long for many interactive applications.

	Node Data Density		Round Trip Delay	
Node Type	Min (Mbps/km^2)	Max (Mbps/km^2)	Min (millisec)	Max (millisec)
LMDS	3.	30.	0.003	0.060
HALO	2.	20.	0.10	0.35
LEO (Broadband)	0.002	0.02	2.50	7.50
GEO	0.0005	0.02	200.	240.

The HALO Network can serve as a valuable adjunct to a broadband satellite network. Relative to the HALO Network, satellites have limited power available to their payloads. Satellites require costly premise equipment. They have their service frequencies regulated by the ITU. And, they can become saturated over dense populations of end users. The HALO Network integrated with a satellite network can increase the

throughput, competitiveness, and revenue of a satellite constellation.

HALO Networks and/or HALO aircraft can enhance satellite networks:

- HALO aircraft have comparatively higher power available to the payload. The baseline power buss of the HALO airplane can deliver more than 20 KVA, typically 2 to 10 times higher than satellites.
- Because of the relatively short distance between the HALO node and the end user (10 to 35 miles), low-cost, low-power premise equipment can be used. The premise equipment requires a single beam with slow angular tracking, instead of two beams for LEO constellations.
- The HALO Network does not require ITU coordination. Frequencies assigned to the HALO Network are within the control of the local PTT. In the U.S., for example, the HALO Network can utilize 24 GHz, 28 GHz, and 38 GHz frequency bands licensed to terrestrial service providers. Since the HALO Network is a "frequency agnostic", spectral bandwidths in the 3 to 20 GHz carrier frequency range can also be used for broadband services in other countries.
- The HALO Network can serve hundreds-of-thousands of broadband end users on a metropolitan distance scale. As such, a HALO can operate as a "concentrator" for satellite communications networks. Connections to destinations outside the Cone of Commerce can be made through HALO-to-satellite links.

In summary, the stratospheric HALO aircraft offer three benefits to an integrated HALO-satellite global network:

1. Since HALO aircraft are positioned high above most of the atmosphere, they can easily link to numerous satellites, even those temporarily over areas with sparse populations.
2. The HALO-to-satellite link can use very high carrier frequencies offering ultra-wide bandwidths.
3. The HALO can be the front-end of an integrated system. The airplane and its communications systems can be accessed each day. The integrated network can thus be steadily evolved (even radically changed, if necessary).

While HALO Networks can enhance the value of satellite networks in a combined network, is such approach regrettably only sprinkling perfume at a decaying corpse? Are the finances required and the risks too high for a stand-alone satellite network? Can an "All Stratospheric Network," one with a stratospheric platform (SP) node above each major population center and with inter-SP links connecting the nodes, if engineered well from the date of conception onward, be a much better solution for a country needing a modern broadband data communications infrastructure? The advantages of an "all stratospheric" solution may be very compelling and justify the careful attention of individuals possessing keen intelligence and sharp vision.

1. Summary

The HALO Network can provide wireless broadband communications services. The feasibility of this network is reasonably assured due to a convergence of technological advancements. The key enabling technologies at hand include GaAs (Gallium Arsenide) RF modules operating at MMW frequencies, ATM/SONET technology, digital signal processing of wideband signals, video compression, ultra-dense memory modules, lightweight aircraft technology including composite airframes and small fanjets capable of operating reliably at low Mach and low Reynolds numbers. These technologies are available, to a great extent, from vendors targeting commercial markets. The HALO Network is predicated on the successful integration of these technologies to offer communications services of high quality and utility to small and medium sized businesses at reasonable prices. The regulatory climates of the FAA and the FCC are favorable, though the political clout of satellite companies is formidable.

While a variety of broadband access modalities are promising for the U.S. market, the HALO Network may be a winner for a "green field" deployment, especially in a region where the existing infrastructure is not amenable to an upgrade or retrofit, ala xDSL. The HALO Network will be better suited than satellites to delivering broadband services to major cities, if forced to compete directly. On the other hand, the HALO Network can be a valuable asset to satellite operators by either offering back-hauling of "Cone of Commerce" traffic, seamlessly extending next-generation mobile services to the city from the surrounding rural areas, enhancing broadband services as a "concentrator," or by enhancing local content.

We, the participants of the First Stratospheric Platforms Workshop, owe the people of the world our attention to the following seminal, pivotal questions:

- Is the stratosphere a better domain, a better layer, than Earth orbit for providing a bandwidth-on-demand "bit cloud" over each of the major cities?
- Will stratospheric platforms better utilize spectrum controlled and licensed by the world's regulatory agencies than satellites when offering broadband communications services vital to electronic commerce?
- Will stratospheric communications stimulate rapid growth of regional commerce?
- Can the communications equipment of stratospheric platforms be customized to best serve the communications needs of a local population?
- Will stratospheric platforms benefit the ecosystem by reducing automobile traffic by promoting telecommuting, distant learning, video conferencing, electronic commerce, or other "remote access" applications?

If after we carefully answer the questions posed above, and others of a strategic policy nature that may be articulated at this workshop, and if we find the societal benefit potential of stratospheric communications to be compelling, then the following proactive steps will need to be taken soon:

- Petition the spectrum regulatory bodies in Japan, Europe, the FCC in the United States, and the ITU to institute a "Moratorium" on the allocation of spectrum for primary use by satellites. This action will grant a critical period of time for carefully examining the potential of the stratosphere.
- File key policy requests with the leading Governments of he world beseeching them to promote a "climate" hospitable and friendly to the development, demonstration, and deployment of stratospheric communications networks.
- Stimulate a world forum where technologists, vendors, service providers, and government policy makers can routinely meet and exchange breakthrough ideas for accelerating the growth of stratospheric communications.

I believe that we have a grand opportunity to develop a completely new layer of communications, one not tainted by vestiges of the Cold War. Let us seize the challenge to look deeply and creatively into the first century of a new millennium. May we offer humanity a new means for realizing prosperity.

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REFERENCES

1. J. Martin and N. Colella, "Broadband Wireless Services from High Altitude Long Operation (HALO) Aircraft," *Proc. of the SPIE International Symposium on Voice, Video, and Data Communications: Broadband Engineering for Multimedia Markets*, 1997.
1. N. Colella and J. Martin, "The Cone of Commerce," *Proc. of the SPIE International Symposium on Voice, Video, and Data Communications: Broadband Engineering for Multimedia Markets*, 1997.
2. G. Djuknic, J. Freidenfelds, et al., "Establishing Wireless Communications Services via High-Altitude Aeronautical Platforms: A Concept Whose Time Has Come?," *IEEE Communications Magazine*, September 1997.

BIOGRAPHY

Dr. Nicholas J. Colella is the Chief Technology Officer of Angel Technologies Corporation. In prior years, he held senior technical positions at Lawrence Livermore National Laboratory. He invented the RAPTOR/TALON theater ballistic missile defense concept and served as DOD's executing agent for pioneering low-cost, high-altitude, long-endurance unmanned aircraft, high mass fraction kinetic kill interceptors, electro-optics and communications systems. He co-created Brilliant Pebbles, led LLNL's spacecraft design and survivability projects, and developed one-steradian wide field of view (WFOV) cameras employing spherically concentric refractive optics for tracking satellites and space objects. He is a founding partner of a multi-chip module company and the National Robotics Engineering Consortium at Carnegie Mellon.

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